[001]Planetary Transmission

[002]

[003]

[004] The present invention refers to a planetary transmission, in particular for machine tools, according to the preamble of claim 1.

[005]

[006] This planetary transmission, mostly built as a single- or multiple-stage planetary transmission, is basically implemented in machine tools, as well as in lathes, milling machines and machining centers. The selectable planetary transmission increases the service scope of the main spindle motors, as well as the flexibility of the machine tool for processing the different work materials through increasing high torques or high speeds. For example, two transmission stages may be built in, while on one hand the drive shaft which is connected to a sun gear with an internal gear and on the other the internal gear can be coupled to the housing. A planetary carrier is connected to the output shaft.

[007] In DE A 199 17 673 of the applicant, there is such a two-stage planetary transmission, with a drive shaft and an output shaft which are mounted in the housing over roller bearings. The drive shaft is connected to a sun gear which engages with the planetary gears which are mounted over bearings on planetary bolts in a planetary carrier, which is connected over a positive fit connection with the output shaft. The planetary gears mesh with an internal gear, which is mounted over the roller bearings in the housing or in the rotating planetary carrier and positively fit with a hub connection. The hub is connected in a slip free manner, over an external gearing, with the first part of the sliding collar.

[008] A roller bearing is located over the sliding collar. The external part is axially displaceable in the housing, running over bearing bolts, whereby the axial displacement of the external part is carried over the roller bearings.

[009] The sliding collar can be placed in three operating positions and one neutral position. In the first operating position, the internal gear is coupled with the housing by a turret gearing. In the second operating position, the internal gear is coupled

with the sun gear by a turret with a synchronizing gear and a positive locking connection. The turret is thereby connected in a slip free manner with the drive shaft.

[010] The sliding collar displacement takes place through a switching mechanism, whose actuator is an electromagnet or a motorized switching unit and whose armature is connected with the sliding collar by means of a pinion.

[011] In modern machine tools, the basic requirements of rotational speed, vibration value and accuracy are always increasing. The planetary transmission, which is a part of the machine tool transmission, is therefore a potential source of vibration that when the rotational speed increases can negatively influence the working surface.

[012] The causes for vibration is based, among other things, on the unbalancing of the planetary transmission. The coupling parts such as the sliding collar require clearance so that they can move. The clearance in turn leads to an nonconcentric rotation, which generates unbalancing. For example, a sliding collar with the common weight of 1.6 kg can only move 0.1 mm from the center position, therefore the resulting unbalance is equal to 160 g-mm, which generates an extreme vibration. A planetary transmission operating under high rotational speed (i = 1:1) demands a detailed processing of the work piece surface, which can only be achieved with low vibration machine tools.

[013]

[014] The purpose of the present invention is to create a planetary transmission to process work pieces at high rotational speeds under little or no vibration.

[015] This task is solved starting with a planetary transmission of the mentioned front-end type with the characteristic features indicated in patent claim 1 and whose beneficial embodiments are described in the subsequent claims.

[016] The invention emanates from a planetary transmission, in particular from a two-stage planetary transmission for machine tools with a drive shaft which is connected to a sun gear, with an output shaft which is connected to the planetary carrier, with an internal gear that in the first operating position can engage with the housing and in the second operating position engages with the sun gear, with a hub

that concentrically surrounds the drive shaft, and with a sliding collar which concentrically surrounds the hub and that remains in contact with the hub in one of the two operating positions.

[017] According to the invention, it is foreseen that the sliding collar is placed concentrically over the hub axle's center bore in the turned-away side of the interior gear, which is placed in the engaged position of the sliding collar with the hub, concentric with the hub's axle and over its centering collar.

[018] This so-called "captive" sliding collar, which in the first operating position is placed over the hub's centering collar, exhibits the benefit that the sliding collar in this operating position has significantly smaller play between the hub and the sliding collar than in common planetary transmissions, which merely exists from the play between the centering bore and the centering collar. The present function namely produces a positive fit connection between the sliding collar and the hub.

[019] In a further embodiment of the invention, the sliding collar bearing will be fixed in the axial direction with a shrunken holding ring. This offers the advantage that no additional unbalancing is produced.

[020] In a further embodiment of the invention, the sliding collar first of all comes in contact with the hub centering collar by approaching the centering bore, transverse to the displacement direction of the running edge of the centering bore provided with a chamfer. The centering collar it can also first of all come in contact with the centering bore by this approach, transverse to the displacement direction of the running edge of the centering bore provided with a chamfer.

[021] This offers the additional benefit that also with a small disalignment of the sliding collar to the hub, the centering bore can run with no problems from the centering collar.

[022]

[023] The invention can be explained in more detail with the following drawings, in which beneficial application examples of planetary transmissions designed according to the invention are represented.

[024] The only Fig. is a partial section of a planetary transmission, which is built as a two-stage planetary transmission and is intended for deployment in a machine tool.

[025]

[026] The planetary transmission shows a drive shaft 1 which is connected to a sun gear 2, as well as an output shaft 3 which is connected to a planetary carrier 10, whereby one of the planetary gears is identified with number 11. It further shows an internal gear 4, that in its first operating position engages with housing 12 of the planetary transmission, and in its second operating position engages with sun gear 2 aided by hub 6. Hub 6 concentrically surrounds drive shaft 1. The sliding collar is identified with number 5, which actuates the switch between both operating positions. Sliding collar 5 is thereby axially and movably mounted in bearings over internal gear 4.

[027] In the upper half of the single figure, the sliding collar 5 is shown engaged with the braking disc 14, whereby this operating position corresponds to the $i > 1$ transformation of the two-stage planetary transmission.

[028] According to the invention, the sliding collar 5 is intended to be placed in the loose side of internal gear 4 with a centering bore 7 concentrically located over hub 6, as is depicted in the lower half of Fig. 1, where $i = 1$ in the engagement position, sliding collar 5 is engaged with hub 6 concentrically over the axle of hub 6 and is placed over the designed centering collar 8.

[029] Beneficially, centering bore 7 first of all comes in contact with the centering collar 8 when it approaches the lying edge of the beveled centering bore, diagonally to the displacement direction. In a likewise beneficial way, it is intended that centering bore 7 approaches the centering collar 8, which first of all comes in contact diagonally to the displacement direction of the running edge of the centering collar with a bevel, so that it is possible to have a trouble-free displacement of the centering bore with the centering collar, with a minor disalignment between the centering bore 7 and centering collar 8.

[030] The existing play surrounding and resting between centering collar 8 and centering bore 7, as it has been already mentioned, is significantly smaller than the

existing play between the sliding collar and the internal gear teeth of common planetary transmissions.

[031] On the upper section of centering bore 7 there is a specially shrunk holding ring 9 intended for the sliding collar bearings 13. This axially fixed holding ring 9 is intended to have as little additional unbalancing as possible.

[032] Let it also be emphasized that a centering between the sliding collar 5 and hub 6 is not necessary for the operating position ($i > 1$) represented above in the Fig., as in this operating position the sliding collar 5 stays and engages with the brakes or the braking disc 14.

[033] The design of a centering bore at the end of the sliding collar interacting with a hub, as well as a centering collar shrunk in the hub, does not apply only to planetary transmissions for machine tools, but it is also applicable in all similar transmissions in which the sliding collars engage with a hub or with another connecting element, for example in automobile transmissions, whereby smoothness will also be increased and the idle running noise in the transmission is significantly reduced.

Reference signs

1	Drive shaft
2	Sun gear
3	Output shaft
4	Interior gear
5	Sliding collar
6	Hub
7	Centering diameter
8	Centering collar
9	Holding ring
10	Planetary carrier
11	Planetary gear
12	Housing
13	Sliding collar bearings
14	Braking disc